REMARKS

This Amendment is in response to the Final Action mailed August 5, 2003. The Office Action rejected claims 1-43 under 35 U.S.C. § 102(b). Applicants have amended claim 1, 11, 12, 25, 35, and 36. Claims 39-43 have been cancelled.

Claims 1-38 remain pending in the application. Reconsideration in light of the amendments and remarks made herein is respectfully requested.

Rejections Under 35 U.S.C. § 102

1. The Office Action rejected claims 1-43 under 35 U.S.C. § 102(b) as being anticipated by Mushiage et al. ("Mushiage") (U.S. Patent No. 5,933,443).

The present invention relates to a semiconductor laser. One object of the invention is to provide a semiconductor laser, whose laser characteristics are improved, for example, by lowering the threshold current and in which practicability is maintained.

Applicants found that the deterioration of the laser characteristics such as an increase of the threshold current is mainly caused when the current-blocking layer is etched by the phosphorous compound gas used in the thermal cleaning process, which is a process performed before the crystal growth on the current-blocking layer. As a result of studying the conditions under which the etching occurs, as shown in Fig. 2 of the present application, Applicants found that there is a correlation between the carrier concentration of the current blocking layer and the extent to which etching occurs.

In order to achieve stated objective described above, one embodiment of the provides that the current-blocking layer is of either $A1_{0.5}In_{0.5}P$ or $(A1_xGa_{1-x})_{0.5}In_{0.5}P(0.7<x<1)$.

Applicants have amended independent claims 1, 11, 12, 25, 35, and 36 to more clearly claim the invention. In particular, these claims now recite, "wherein the current-blocking layer includes either $Al_{0.5}In_{0.5}P$ or $(Al_xGa_{1-x})_{0.5}In_{0.5}P$, where $0.7<x<1$."

These amendments are supported by the specification of the present application, where it is stated that either AlInP or $(Al_xGa_{1-x})_{0.5}In_{0.5}P(0.7<x<1)$ may be used in the current-blocking layer 13 (for each of the two regions 13a and 13b having the n-type carrier concentrations N1 and N2, respectively) (see Application page 28, line 24 to page 29 line 1; and page 34, lines 20 to 22). In addition, in the fourth embodiment described in the specification, it is stated that the first layer of the current-blocking layer 16 is of the p-type $Al_{0.5}In_{0.5}P$ (see Application page 34, lines 16 to 18).

Applicants submit that the amendments made herein are patentably distinguishable from what is taught in the cited reference.

In additional to the newly added limitation of "current-blocking layer includes either $Al_{0.5}In_{0.5}P$ or $(Al_xGa_{1-x})_{0.5}In_{0.5}P$, where $0.7<x<1$", Applicants also note that at least one of the following three limitations (A, B, and C) are found in each one of amended independent claims 1, 11, 12, 25, 35, and 36.

Limitation A: The current-blocking layer is of the n-type, and the carrier concentration of the region on the lower layer side, N1, is lower than the carrier concentration of the region on the upper layer side, N2 (Claims 1 and 25).

Limitation B: The current-blocking layer includes a p-type region and an n-type region. The p-type region is in the vicinity of the interface between the cladding base layer and the p-

type buried cladding layer. The n-type region is part or all of the rest of the current-blocking layer (Claims 11 and 35).

Limitation C: The current-blocking layer is of the n-type. A p-type interjacent layer, which is of either $Al_{0.5}In_{0.5}P$ or $(Al_xGa_{1-x})_{0.5}In_{0.5}P(0.7<x<1)$, is disposed between the current-blocking layer and the p-type cladding base layer. (Claims 12 and 36).

In the semiconductor laser of the present invention, the current-blocking layer is of either $Al_{0.5}In_{0.5}P$ or $(Al_xGa_{1-x})_{0.5}In_{0.5}P(0.7<x<1)$, each having a lower refractive index than the prior art current-blocking layers; therefore, absorption loss is less likely to occur. Consequently, the semiconductor laser of the present invention has a lower oscillation threshold current and is more advantageous in obtaining a high output.

Further, it is known that when the current-blocking layer is etched during the process of crystal growth on the current-blocking layer, the laser characteristics deteriorate, e.g., the threshold current becomes higher. According to the present invention, it is possible to solve the problem of having the current-blocking layer etched by including one of Limitations A, B, or C.

As a result of the one or more of Limitations A, B, and C, the semiconductor laser of the present invention has a lower oscillation threshold current and, consequently, guaranteeing a high output.

In contrast to the present invention, the cited reference of Mushiage does not disclose a current-blocking layer of either $Al_{0.5}In_{0.5}P$ or $(Al_xGa_{1-x})_{0.5}In_{0.5}P$ $(0.7<x<1)$ combined with an arrangement of one of Limitations A, B, and C. Consequently, because the semiconductor laser

disclosed in Mushiage does not disclose any of these elements A, B, or C, it is impossible for Mushiage to have a lower oscillation threshold current while a guaranteeing a high output.

Referring to Mushiage, Column 3, Lines 29 to 35, it is mentioned that an n-type first block layer of AlInP and an n-type second block layer of $Al_tGa_{1-t}InP$ are formed; however, the carrier concentration of the first block layer and the carrier concentration of the second block layer are both $2x10^{18}/cm^3$. Thus, neither Limitation A, B, or C is present.

Additionally, in Column 5, Lines 47 to 50 of Mushiage, it is mentioned that a p-type first block layer of $Al_sGa_{1-s}InP$ and an n-type second block layer of GaAs are formed, and the carrier concentration of the first block layer (i.e. $2x10^{18}/cm^3$) is lower than that of the second block layer (i.e. $5x10^{18}/cm^3$). However, since the first block layer is the p-type, Limitation A is not present. Further, the materials used in the n-type second block layer of Mushiage are different from the materials in the block layer of the claimed invention.

Furthermore, the p-type first block layer disclosed in Column 5, lines 47 to 50 of Mushiage is of $Al_sGa_{1-s}InP$. It is neither $Al_{0.5}In_{0.5}P$ nor $(Al_xGa_{1-x})_{0.5}In_{0.5}P(0.7<x<1)$ as claimed in the amended claims 1, 11, 12, 25, 35, and 36. Thus, Limitation C is not disclosed or suggested by Mushiage.

Moreover, the cited reference of Mushiage does not include any statement suggesting the findings on which the present invention is based, namely "the main cause of deterioration of the laser characteristics is the etching occurs in the current-blocking layer" and "there is a correlation between the carrier concentration of the current-blocking layer and the extent to which etching occurs."

In conclusion, the invention claimed in Claims 1, 11, 12, 25, 35, and 36 is not taught or suggested by Mushiage. Withdrawal of the §102(b) rejection of claims 1-38 is respectfully requested.

Conclusion

In view of the amendments and remarks made above, it is respectfully submitted that the pending claims are in condition for allowance, and such action is respectfully solicited. Authorization is hereby given to charge our Deposit Account No. 19-2814 for any charges that may be due. Furthermore, if an extension is required, then Applicants hereby request such an extension.

Respectfully submitted,

SNELL & WILMER L.L.P.

I hereby certify that this document and fee is being deposited on October 23, 2003 with the U.S. Postal Service as first class mail under 37 C.F.R. § 1.8 and is addressed to Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

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